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Bern, 3 June 2004/cg
our ref. RS/RS-16071
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Our File 16071
International Patent Application No. WO 03/084037; Delta Energy Systems (Switzerland) AG – Written Opinion of 29 April 2004

Dear Sirs,

1 New claims

In response to the written opinion of 29 April 2004 with respect to the International Patent Application in caption please find enclosed a new set of claims 1 to 17 (replacement sheets 23-26). The international preliminary examination report shall be established on the basis of these new claims.

In the claims, the following amendments have been made:

- Claim 1 has been amended by incorporating the feature that the power converter comprises "a switch on a primary side of the magnetic storage element;";
- in claim 1 the term "a switching device having a ..." has been replaced by the term "a synchronous rectifier on a secondary side of the magnetic storage element having a ...";
- in claim 1 the term "enabling or disabling said switching device" has been replaced by the term "enabling or disabling said synchronous rectifier";
- in claim 1 the term "a network wherein said switching device input, said switching device output, and the load" has been replaced by the term "a network wherein said switching input, said switching output and the load";
- claim 15 has been amended by clarifying that the power input portion comprises a switch: "providing a power input portion comprising a switch;

- in claim 15 the term "a power output portion comprising a switching device ..." has been replaced by the term "a power output portion comprising a synchronous rectifier ...";
- in claim 15 the term "enabling or disabling said switching device" has been replaced by the term "enabling or disabling said synchronous rectifier";
- in claim 15 the term "a network wherein said switching device input, said switching device output, and the load" has been replaced by the term "a network wherein said switching input, said switching output and the load".

The remaining claims are not amended.

2 Patentability

2.1 Novelty

The examiner alleges that Murata discloses all features of the invention as claimed in the independent claims 1 and 15. The examiner particularly alleges that Murata discloses a control circuit which determines the rate of change of the bias voltage, that this rate of change is characterised and the main switch is controlled in dependency of this characterisation. In order to support his opinion, the examiner inter alia refers to column 4, lines 6-12, lines 41-46 and paragraph [0019]. The examiner even cites the text passage "..., the output voltage of the bias winding 8 decreases to be less than a voltage ..." in paragraph [0019].

The applicant agrees that Murata discloses a converter that includes a bias winding with a control circuit that controls the switching of the main switch. However, the applicant does not agree with the examiner that Murata discloses the main features of the invention, namely a control circuit that determines the rate of change of the bias voltage where the main switch is controlled in dependency of a characterisation of that rate of change.

The text passages in columns 4 and 5 the examiner refers to read as follows:

lines 6-15: *The above rectifying smoothing circuit 10 rectifies and smoothes the output voltage from the bias winding 8 and outputs it to the mode switching circuit 11. When the rectifying smoothing output voltage of the rectifying smoothing circuit 8 is a certain voltage or higher, the mode switching circuit 11 is turned on to set a continuous current mode. Furthermore, when the rectifying smoothing voltage is less than the certain voltage, the mode switching circuit 11 is turned off to set a discontinuous current mode.*

lines 41-46: *... accordingly, when the secondary winding is heavily loaded, the absolute value of the voltage of the rectifying smoothing circuit 10 provided for the bias winding 8 increases, and on the contrary when the secondary winding is lightly loaded, the absolute value of the voltage of the rectifying smoothing circuit 10 decreases.*

lines 54-4: *That is, when the switching power supply unit is in a waiting state, the output voltage of the bias winding 8 decreases to be less than a voltage determined by the turn ratio, and accordingly the rectifying smoothing voltage of the rectifying smoothing circuit 10 decreases and the mode switching circuit 11 detects the decrease and sets a continuous current mode. Then, because the turn-on delay circuit 12 sets a long delay time, the oscillation frequency of the MOSFET 4 decreases.*

In short: Murata discloses that the bias voltage *(the output voltage from the bias winding 8)* is rectified, smoothed and then compared with a threshold voltage *(When the ... voltage of the rectifying smoothing circuit 8 is a certain voltage or higher ...)*. If the bias voltage is higher (lower) than the threshold voltage, the power supply is set to continuous (discontinuous) current mode.

Murata therefore teaches to determine whether the (rectified and smoothed) bias voltage is higher or lower than a threshold voltage. If it is higher some action is taken. If it is lower, another action is taken. But Murata does not consider how long it took the voltage to become higher (or lower) than the threshold. That is, the action taken is always the same whether the voltage increased very fast or very slow.

In contrast hereto, the invention teaches to determine the rate of change of the bias voltage. (In fig. 9b, the term "slew rate" has been used instead of the term "rate of change".) This means that it is determined, how fast the bias voltage increases or decreases, independent of whether it reaches a given threshold or not. Hence, if the bias voltage increases fast, some action is taken, while another action is taken, when the bias voltage increases slowly. It therefore does not matter whether the bias voltage is higher or lower than a threshold voltage.

One exemplary and preferred embodiment of the control circuit for use in a power converter according to the invention is shown in fig. 8. Here, the rate of change of the bias voltage (or the secondary voltage; see for example the description on page 14, line 27 - page 15, line 5) is determined by determining whether the bias voltage exceeds a threshold voltage <u>within a given time interval</u> (delay). The bias voltage is judged to increase fast, when it exceeds the threshold within the given delay and the bias voltage is judged to increase slowly when it does not exceed the threshold within the delay. If the bias voltage exceeds the threshold within the delay some action is taken and if the bias voltage does not exceed the threshold within the delay (but may exceed the threshold afterwards) another action is taken. In this embodiment the bias winding is compared with a threshold voltage too. However, in contrast to Murata, it is determined whether the bias voltages exceeds the threshold voltage within a given time interval or not. So, also in this embodiment the rate of change of the bias voltage is determined.

While the invention teaches to determine the rate of change of the bias voltage, that is whether the bias voltage increases fast or slow, Murata just teaches to determine whether the bias voltage is higher or lower than a threshold. Murata does therefore not disclose the feature that the rate of change of the bias voltage is determined. Furthermore, since Murata does not determine the rate of change of the bias voltage, Murata does not disclose the features that the rate of change is characterised and that the main switch is controlled depending on this characterisation.

Hence, Murata does not disclose the essential features of the invention. The invention as claimed is therefore new.

2.2 Inventive step

As outlined above, neither Murata nor any other cited document discloses the features that the rate of change of the bias voltage is determined and that the switching of a switch is controlled depending on that rate of change.

In other words, it was neither known in the prior art to determine the rate of change of a bias voltage nor to control a switch depending on the rate of change of a bias voltage. It therefore can not be obvious for a person skilled in the art to incorporate these features into a power converter.

Hence, the claims are patentable because they are new and involve an inventive step.

3 Clarity

In order to clarify the claims, the independent claims 1 and 15 have been amended as proposed by the examiner. Both claims now incorporate the features that the power converter includes a switch on the primary side (power input portion) and a synchronous rectifier on the secondary side (power output portion).

4 Examination report

As the new set of claims overcomes all of the objections of the Written Opinion a positive international preliminary examination report can be expected.

In the case the examiner requires further clarifications or does not agree with the above comments he is kindly asked for a call-back.

The representative:

Werner A. Roshardt, Patent Attorney

- Replacement sheets 23-26 (4 pages)
- Form of acknowledgement of receipt (only by mail)

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CLAIMS:

1. A power converter for supplying an output power to a load, comprising:

a magnetic storage element;

a switch on a primary side of the magnetic storage element;

a synchronous rectifier on a secondary side of the magnetic storage element having a switching input, a switching output and a control input for enabling or disabling said synchronous rectifier from conducting current from said switching input to said switching output; and

a network wherein said switching input, said switching output and the load are connected together in a circuit;

a bias winding in said circuit for producing a bias voltage representative of the output power;

characterized in that said power converter comprises

a control circuit for

(a) determining the rate of change of said bias voltage,

(b) characterizing said rate of change, and

(c) controlling said control input as a result of the characterization (b).

2. The power converter of claim 1, further comprising a power input portion and a power output portion for providing said output power, wherein said circuit is in said power output portion.

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3. The power converter of claim 2, further comprising a connecting portion for coupling said power input portion to said power output portion, wherein said connecting portion includes an inductor as part of said power output portion, wherein said bias winding is coupled in series with said inductor.

4. The power converter of claim 3, wherein said connecting portion includes a transformer having a primary winding as part of said power input portion and a secondary winding which includes said inductor.

5. The power converter of claim 1, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

6. The power converter of claim 2, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

7. The power converter of claim 3, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

8. The power converter of claim 4, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

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9. The power converter of claim 5, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

10. The power converter of claim 5, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

11. The power converter of claim 6, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

12. The power converter of claim 7, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

13. The power converter of claim 8, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

14. The power converter of claim 9, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

15. In a power converter, a method for supplying an output power to a load, comprising the steps of:

providing a magnetic storage element;

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providing a power input portion comprising a switch;

providing a power output portion comprising a synchronous rectifier having a switching input, a switching output and a control input for enabling or disabling said synchronous rectifier from conducting current from said switching input to said switching output, and a network wherein said switching input, said switching output and the load are connected together in a circuit;

providing a bias voltage representative of the output power;

characterized in that said method further comprises the steps of

determining the rate of change of said bias voltage;

characterizing said rate of change; and

controlling said control input as a result of said step of characterizing.

16. The method of claim 15, wherein said step of determining includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and wherein said step of characterizing includes comparing the change in said bias voltage in said step of determining to a reference.

17. The method of claim 16, wherein said step of characterizing includes determining whether the rate of change is either high or low compared to said reference.